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More Evidence on Income Distribution and Growth

George R. G. Clarke

Inequality is *not* a necessary condition for growth. Indeed, inequality is associated with slower growth — perhaps because increased inequality causes more conflict over distributional issues, encouraging greater economic intervention and higher taxes.

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This paper — a product of the Transition and Macro-Adjustment Division, Country Economics Department — is part of a larger effort in the department to understand the determinants of economic growth. The study was funded by the Bank's Research Support Budget under research project "How Do National Policies Affect Long-Run Growth?" (RPO 676-66). Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Rebecca Martin, room N11-054, extension 39065 (December 1992, 28 pages).

Inequality is often regarded as a necessary evil that has to be tolerated to allow growth, says Clarke. The view that inequality is necessary for the accumulation of wealth, and contains the seeds of eventual increases in everyone's income is evident in "trickle down" economic theories, where societal acceptance of inequality allows the rich to earn a greater rate of return on their assets.

Others argue that inequality slows growth — because increased inequality causes more conflict over distributional issues, thereby encouraging greater economic intervention and higher taxes.

According to Clarke, the empirical evidence shows that:

• Inequality is negatively, and robustly, correlated with growth. This result is robust to many different assumptions about the exact form of the cross-country growth regression.

• Although statistically significant, the magnitude of the relationship between inequality and growth is relatively small. Decreasing inequality from one standard deviation above to one standard deviation below the mean increases the long-term growth rate by about 1.3 percentage points a year.

• Inequality has a similar effect in democracies and non-democracies. When an interaction term between the type of regime and inequality is included in the base regression, it is insignificant at conventional significance levels.

• The cross-country data on inequality follows Kuznets' inverted-U shape.

Care should be taken in interpreting these results. Although inequality is negatively correlated with growth, this does not necessarily imply that "soak-the-rich" policies will improve long-term growth.

First, theoretical work on inequality and growth stresses that this negative correlation is caused by high levels of inequality provoking high levels of government economic intervention. Soak-the-rich policies may be less necessary where there is less inequality.

Second, although the partial correlation is robust, the direction of causality has not been determined and the effects of specific income distribution policies have not been tested.

Finally, if policies designed to decrease inequality result in greater government consumption and the cost of increased government consumptions outweighs the benefits of greater equality, long-term growth may be harmed.

But for certain: inequity is not a prerequisite for growth.

More Evidence on Income Distribution and Growth.

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More Evidence on Income Distribution and Growth.

I. Introduction

Inequality is often regarded as a necessary evil which has to be tolerated to allow growth. Adelman and Robinson (1989) state "it has been argued that inequality is necessary for accumulation, and that it therefore contains the seeds of eventual increases in everyone's income".[1] This view is evident in "trickle down" economic theories where societal acceptance of inequality allows the rich to earn a greater rate of return on their assets, encouraging them to accumulate wealth faster; some of which can be redistributed to make everyone wealthier. In the Harrod Domar model, if the rich save a greater share of income than the poor, transfers of wealth from rich to poor reduce capital accumulation, thus leading to slower growth.[2] In contrast, Alesina and Rodrik (1991) and Persson and Tabellini (1990) argue that inequality actually slows growth. This is because increased inequality causes greater conflict over distributional issues, thereby encouraging greater government intervention into the economy and higher taxes. This lowers the rate of return on private assets, restricting capital accumulation and slowing growth. Both Alesina and Rodrik (1991) and Persson and Tabellini (1990) confirm these theoretical predictions with cross country growth regressions.[3] However, a well known property of these regressions is that results are highly dependent upon the other variables included in the regression (Levine and Renelt (1992)).

This paper argues that the empirical evidence supports the assertion that inequality is negatively associated with long run growth. This result is robust to many different assumptions about the exact form of the cross country growth regression. In addition, this observed negative correlation is not dependent upon political regime - whether a country is a democracy or not. When an interaction term

[1] Adelman and Robinson, p951.

[2] Fields(1989), p173.

[3] In addition Persson and Tabellini (1990) confirm their results with a historical panel data set.

between type of regime and inequality is included in the base regression, its coefficient is insignificant. This indicates, in contrast to Alesina and Rodrik (1991), that inequality has a similar effect on both democracies and non democracies. The paper is set up as follows: the second section of the paper discusses properties of the inequality data, including Kuznets' Inverted U hypothesis and simple correlations with other variables. The third section shows preliminary results from cross country regressions with inequality measures included. In the fourth section the robustness of the correlation between inequality and growth is tested using a variant of extreme bounds analysis. The final section discusses results and makes final comments.

II. Properties of the Inequality Data

In order to include "inequality" in cross country growth regressions, the abstract concept of inequality needs to be quantified. Since there is no single universally accepted measure of inequality, various measures are constructed to test that results are not dependent on inequality being measured in a particular way. The measures are the coefficient of variation (COEFFVAR), Theils' index (THEIL), and the Gini coefficient (GINI). Additionally, the ratio of the share of total income earned by the poorest forty percent of the population to the share of total income earned by the richest twenty percent of the population, the measure used in both Alesina and Rodrik (1991) and Persson and Tabellini (1990), is computed.

The Gini Coefficient, probably the most common inequality measure, is derived from the Lorenz curve, a graphical device which represents inequality in a society. The Lorenz curve plots $F(z)$, the share of population with income less than z, against $\Phi(z)$ the share of total income of people with income less than z. It is important to note that this curve must lie below the 45 degree line. For example, suppose $F(z) = \frac{1}{2}$ and that $\Phi(z) > \frac{1}{2}$, this would imply that the poorer half of the population earned more than half of total income, which therefore is more than the richer half could earn. The Gini coefficient is

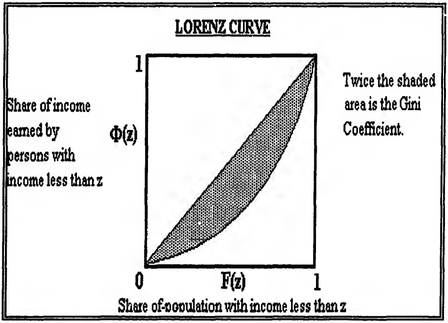

Figure 1

twice the area between the Lorenz curve and the 45 degree line (See Figure 1)[4].

In order to describe the other two measures it is useful to suppose there are n persons in the population with incomes $y_1, y_2, \ldots, y_n$. The variance of the incomes may seem an intuitive way to judge how spread out incomes are from the mean. However multiplying all incomes by a factor of n increases the variance by a factor of n squared. So, for example a society where half the population earned \$4 a year and half \$60 would be (four times) more unequal than if half the population earned \$2 and half \$30. The coefficient of variation (COEFFVAR) corrects this problem by dividing the square root of variance by the mean income.

In information theory the entropy of a system is defined as:

where p_i is the probability of event i occurring and $h(p_i)$ is the "value" of knowing event i occurred.

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[4] It is defined as twice the area so that it is between 0 and 1. When $y_i = 1/n$ for all i then it is the 45 degree line and the Gini Coefficient is zero, when one person earns all income then $\Phi(z) = 0$ for $z < y_n$ and $\Phi(z) = 1$ when $z = y_n$. Hence the Gini coefficient for this is 2*(area between 45 degree line and x axis) = 2*(½) = 1.

(1) $$\text{Coefficient of variation} = c = \frac{\sqrt{\frac{1}{n}\sum (y_i - \bar{y})^2}}{\bar{y}}$$

(2) $$ENTROPY = \sum p_i * h(p_i) = - \sum p_i * \log p_i$$

Theil proposed an inequality measure where s_i, person i's share of total income, is substituted into the entropy equation for p_i . The "entropy" of the income distribution reaches a maximum when $s_i = 1/n$ for all i, that is when income is evenly distributed[5]. Theils' index, a measure of inequality, is defined as the "entropy" of income distribution when $s_i = 1/n$ for all i, less the "entropy" of the observed data.

(3) $$\text{Theils' Index} = -\sum \frac{1}{n} * \log(\frac{1}{n}) - (- \sum s_i * \log(s_i))$$

Properties of these indices have been discussed in the literature on inequality.[6] For all measures, the more equitably income is distributed, the lower the measure's value. It should be noted that the measures, other than the ratio are designed to be computed on entire populations. Since this data is unwieldy and less available than the decile income shares, these measures were calculated as if within deciles income is distributed evenly. In general, the Gini coefficient, the coefficient of variation and Theils' index may be preferable to the ratio measure since they utilize more information. A shift in income shares between deciles within the broad groups of the poorest forty percent, the richest twenty percent or the middle forty percent of the population, while not affecting the ratio, changes the other measures.

Although these measures give different values and even different orderings for countries in the sample, they are very highly correlated. (See Table 1). In particular the coefficient of variation and Theils index are extremely highly correlated.

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[5] Recall that the S_i's are constrained to add to one.

[6] See for example Cowell (1977). Or for properties of the Gini coefficient, Lambert (1989).

As an initial exercise, table 2 shows the simple correlations between the inequality variables and Barro regressors and other related variables[7]. Exc., : for per capita GDP, which is negatively correlated with growth, and enrollment rates in secondary, and to a lesser extent primary, education, no variables

Table 1: Simple Correlations of Inequality measures.

	Gini	Coeffvar	Theil	RTP40
Gini	1.00	0.97	0.97	0.91
Coeffvar		1.00	0.99	0.87
Theil			1.00	0.94
RTP40				1.00

TABLE 2: Simple Correlations with Barro Regressors and other Variables

Variable	# obs	Corr. w/ GINI	T stat		# obs	Corr w/ RTP40	T stat
ASSP7085	75	-0.031	-0.26		83	-0.035	-0.31
REVC7085	75	-0.045	-0.39		83	-0.012	-0.11
SGOV7088	76	-0.061	-0.53		84	-0.050	-0.45
SINV7088	76	-0.106	-0.92		84	0.002	0.02
CS7088	81	0.068	0.61		90	0.003	0.03
SGDPPC70	75	-0.319	-2.87		82	-0.255	-2.36
LGDPPC70	75	-0.216	-1.89		82	-0.131	-1.18
CPRIM60	82	-0.166	-1.51		89	-0.095	-0.89
CSEC60	82	-0.373	-3.59		89	-0.317	-3.11
SGDPPCIY	72	-0.354	-3.16		77	-0.290	-2.63
LGDPPCIY	72	-0.225	-1.94		77	-0.162	-1.42
SCONIY	72	0.083	0.69		77	0.024	0.21
SGOVIY	72	-0.208	-1.78		77	-0.170	-1.49
SINVIY	72	-0.120	-1.01		77	-0.039	-0.34

[7] The measures denoted xxxxxIY are measured in the same year as the inequality measures for each country. SCONIY is private consumption as percent of GDP, SINVIY is investment as percent of GDP, SGOVIY is government consumption as percent of GDP and SGDPPCIY is per capita GDP and LGDPPCIY is the log of per capita GDP. All measures are from Summers and Heston (1991).

are highly correlated with inequality. Private consumption (SCONIY) and investment (SINVIY) measured for each country in the same year as the inequality measures are both insignificantly correlated with inequality.

Government consumption (SGOVIY) also measured for each country in the same year as inequality is negatively correlated with the Gini coefficient[8]. If slower growth in countries with greater inequality were caused by greater government intervention in the economy, one may hope to find a significant relationship between greater inequality and large government.

A final aspect of the data regarding the level of development, not the growth rate, is whether the data appears to follow Kuznets' inverted U shape. Kuznets' inverted U hypothesis asserts inequality first increases, and then decreases, as per capita income increases. Various cross country studies have tested this hypothesis and have generally supported it.[9] It has been suggested that this result is driven by the high negative correlation between inequality and wealth among developed countries, and that the increase in inequality observed among the poorer of the less developed countries is largely illusionary.[10] Even if one accepts the hypothesis, questions exist about its causes. The shape may be structural, perhaps caused by a shift from an agrarian base to an industrial base, or could be policy induced.[11] The data used in this study appears to follow the inverted U shape, but the cause of this relationship is not clear. As is customary the hypothesis is tested using log values of GDP. In all four cases when Log GDP is regressed on the inequality measures its coefficient is negative. However, coefficients on two of these

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[8] However this result is very weak since the correlation is only significant at a two tailed significance level of ten percent for two of the four measures, Theil and Gini. The other two measures are insignificantly correlated with SGOVIY instilling little confidence in this result. Additionally, this result appears to be driven by one country, Suriname. When this point is excluded from the sample the correlation becomes insignificant.

[9] See Lecallion et al. (1984), Chapter one, for a survey of some of these studies.However, as noted in Easterly, King, Levine and Rebelo (1991), results from intertemporal studies have not supported the hypothesis. Since the relationship, as it was formulated is intertemporal, these studies would seem a more appropriate way of testing the hypothesis.

[10] Lecallion et al, p14-15.

[11] Adelman and Robinson (1989), p955-57 argue that the initial increase in inequality is caused by a shift from agriculture to industry, but that the following decrease if it occurs is due to policy decisions.

measures are not significant at the five percent level (See Table 3). When squared Log GDP per capita is added to the regression, the regressions' R-Squared term becomes significantly larger and the coefficients on both Log GDP per capita and Squared Log GDP per Capita become highly significant[12] (See Table 4). This result agrees with previous studies which find that in cross country comparisons, the average level of inequality is lower in both very poor and rich countries, than in moderately poor countries.[13] The turning point, where average inequality appears to begin to decrease with increased wealth varies between $1433 for the coefficient of variation, and $1826 for the ratio measure in 1985 prices. This empirical regularity does not necessarily prove the existence of either an intertemporal, or structural relationship between level of development and inequality. The data suffers from the usual problems relating to poor quality, as well as additional problems caused by comparing income distribution data for households and for individuals and using approximations of inequality measures. The "Inverted U" relationship for the Gini Coefficient is shown in figure 2.

Table 3: Regression of Inequality variables on Log of GDP per Capita

Dep. Variable	GINI	COEFFVAR	THEIL	RTP40
No of Obs	72	72	72	77
Constant	0.6102 (6.85)	1.6801 (6.53)	0.7177 (4.42)	7.3076 (3.24)
LGDPPCIY	-0.0220 (-1.94)	-0.0950 (-2.89)	-0.0461 (-2.22)	-0.4076 (-1.42)
R^2	0.05	0.11	0.07	0.03

[12] Third and fourth powers of log GDP per capita are insignificant when added to the regression.

[13] See for example Ahluwahlia (1976).

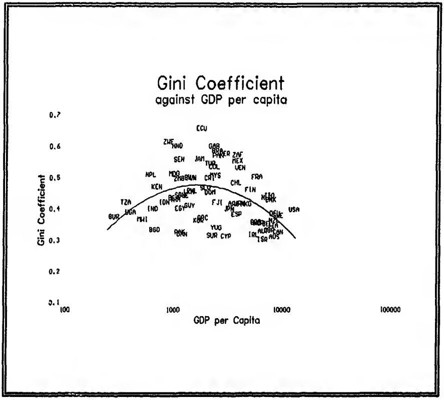

Figure 2

Table 4: Regression of Inequality variables on Log of GDP per Capita and Squared Log of GDP per Capita

Dep. Variable	GINI	COEFFVAR	THEIL	RTP40
No of Obs	72	72	72	77
Constant	-1.6683 (-2.68)	-4.8235 (-2.67)	-3.3680 (-2.96)	-47.346 (-3.02)
LGDPPCIY	0.5780 (3.54)	1.6178 (3.43)	1.0299 (3.45)	13.924 (3.41)
LGDPCIY2	-0.0390 (-3.69)	-0.1112 (-3.64)	-0.0699 (-3.62)	-0.927 (-3.52)
R^2	0.21	0.23	0.21	0.17

III. Regression Results

Table 5 presents the first set of cross country growth regressions. The inequality variables are added to a "Barro type" growth regression including variables to proxy political instability levels, levels of human capital, size of government and initial GDP per capita.

Table 5: Ordinary Least Squares Results for Barro Type Regression with Inequality Variables.

Dep. Var	(1) LGPC7088	(2) LGPC7088	(3) LGPC7088	(4) LGPC7088	(5) LGPC7088
# of Obs	81	74	74	74	81
Constant	0.0154 (1.47)	0.0533 ** (3.14)	0.0394 ** (3.10)	0.0537 ** (3.53)	0.0255 ** (2.29)
SGDPPC70	-0.0023 * (-1.84)	-0.0026 * (-1.79)	-0.0026 * (-1.83)	-0.0027 * (-1.89)	-0.0025 ** (-2.04)
REVC7085	-0.0017 (-0.18)	-0.0040 (-0.43)	-0.0044 (-0.47)	-0.0050 (-0.55)	-0.0030 (0.31)
ASSP7085	-0.0385 ** (-2.03)	-0.0511 ** (-2.27)	-0.0527 ** (-2.37)	0.0531 ** (-2.41)	-0.0405 ** (-2.20)
PPI70DVN	-0.0053 * (-1.95)	-0.0059 ** (-2.28)	-0.0062 ** (-2.42)	-0.0063 ** (-2.48)	-0.0058 ** (-2.18)
CPRIM60	0.0134 (1.22)	0.0116 (1.05)	0.0127 (1.16)	0.0121 (1.12)	0.0175 (1.63)
CSEC60	0.0282 (1.57)	0.0193 (0.94)	0.0152 (0.74)	0.0122 (0.59)	0.0178 (0.98)
SGOV7088	-0.0426 (-1.51)	-0.0595 ** (-2.00)	-0.0606 ** (-2.06)	-0.0604 ** (-2.08)	-0.0479 * (-1.74)
GINI		-0.0691 ** (-2.59)			
THEIL			-0.0438 ** (-2.91)		
COEFFVAR				-0.0298 ** (-3.15)	
RTP40					-0.0022 ** (-2.26)
R-Squared	0.23	0.32	0.34	0.35	0.28

* t statistic significant at 10% level
** t statistic significant at 5% level

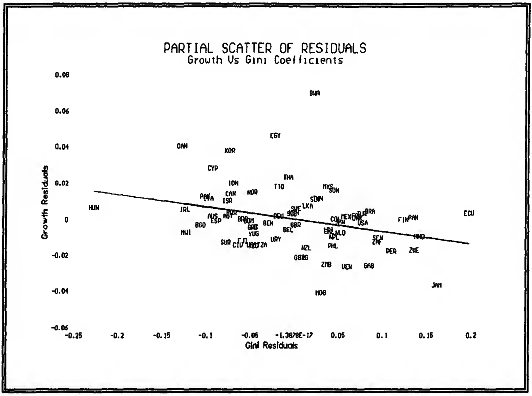

Figure 3

The dependent variable is the least squares growth of rate of GDP per capita (where GDP is taken from BESD, the World Bank data base). The independent variables are initial GDP per capita in constant dollars, from Summers and Heston (1991) (SGDPPC70), primary and secondary enrollment rates lagged ten years (CPRIM60 and CSEC60), the average number of revolutions and coups per year between 1970 and 1985 (REVC7085), the number of assassinations per million population per year between 1970 and 1985 (ASSP7085), the deviation of the price level for investment in 1970 from the sample mean (PPI70DVN) from Summers and Heston (1991)[14] and average government share of GDP between 1970 and 1988 (SGOV7088)[15].

[14] This is the price purchasing parity measure divided by exchange rate relative to the United States.

[15] Barro (1991) uses government share of GDP from Summers and Heston (1988) less expenditure on defense and education. The measure used here, from Summers and Heston (1991), is slightly different in that it does not exclude expenditure on defense and education. The measure used in Barro is not used since it is available only over a shorter subperiod and for a smaller subsample of countries.

In table 5, the coefficients on all inequality measures are significantly negative. For all of the inequality measures, as inequality increases the value of the measure increases. These negative coefficients indicate that increased inequality is correlated with slower long run growth. A primary concern is that one or two outliers may be driving the result. To show this is not the case, a partial scatter of the residuals from growth and the Gini coefficient regressed on the Barro variables is presented in figure three.[16] This appears to confirm that the result is not driven by one or two outliers.

Another concern is heteroskedasticity. This hypotheses is tested using a Breusch-Pagan Lagrange multiplier test with GDP per capita and a Goldfeldt Quandt test [17]. In the Goldfeldt Quandt test, the observations were ordered by GDP per capita and the ten middle observations (twelve middle observations for RTP40) were dropped. The results which reject the null hypothesis of homoskedasticity are presented below.[18]

To correct for heteroskedasticity, the following two regressions are run: OLS with Whites' heteroskedastic consistent standard errors, and weighted least squares weighting by (1/GDP per capita) squared. Correcting for heteroskedasticity does not change the sign or significance of the results. In both cases the coefficients on all inequality variables remain significantly negative at conventional significance levels. In addition, throughout the rest of the analysis, Whites' Heteroskedastic Consistent Standard Errors are used.

[16] Results are similar for the other inequality measures.

[17] The variation of the Breusch - Pagan test suggested by Koenkar(1981) and Koenkar and Barrett(1982) which may be more powerful in the absence of normally distributed errors is used.

[18] In the extended regression listed in table 10 the null hypothesis of homoskedasticity was also rejected. For the Goldfeldt Quandt test the middle eight (nine for RTP40) observations were dropped, and in each case the null hypothesis of homoskedastic errors was rejected at the five percent level. For the Breusch Pagan test on GDP per capita the null hypothesis was rejected at the five percent level for GINI and RTP40 and COEFFVAR, and at the ten percent level for THEIL (significance level of 0.0510).

Table 6: Testing for heteroskedasticity in the residuals from the Barro type regression

H_0: Errors are distributed homoskedastically
H_1: Errors are distributed heteroskedastically

GOLDFELDT QUANDT	Test Statistic	Significance Level
w/ included variable		
GINI	F (23,23) = 8.30	0.000
THEIL	F (23,23) = 8.08	0.000
COEFFVAR	F (23,23) = 8.30	0.000
RTP40	F (26,26) = 4.82	0.000
BREUSCH PAGAN TEST		
w/included variable		
GINI	CHI SQUARED (1) = 4.54	0.033
THEIL	CHI SQUARED (1) = 4.51	0.033
COEFFVAR	CHI SQUARED (1) = 4.40	0.036
RTP40	CHI SQUARED (1) = 5.49	0.019

Table 7 : Ordinary Least Squares with White Heteroskedastic Consistent Standard Errors for Barro Type Regression with Inequality Variables.

Dep. Var	(1) LGPC7088	(2) LGPC7088	(3) LGPC7088	(4) LGPC7088	(5) LGPC7088
# of Obs	81	74	74	74	81
Constant	0.0154 (1.45)	0.0533 ** (3.64)	0.0394 ** (3.34)	0.0537 ** (3.98)	0.0255 ** (2.19)
SGDPPC70	-0.0023 ** (-2.20)	-0.0026 ** (-2.01)	-0.0026 ** (-2.06)	-0.0027 ** (-2.10)	-0.0025 ** (-2.52)
REVC7085	-0.0017 (-0.17)	-0.0040 (-0.37)	-0.0044 (-0.41)	-0.0050 (-0.48)	-0.0030 (-0.28)
ASSP7085	-0.0385 ** (-2.27)	-0.0511 ** (-2.25)	-0.0527 ** (-2.31)	0.0531 ** (-2.32)	-0.0405 ** (-2.43)
PPI70DVN	-0.0053 * (-1.82)	-0.0059 * (-1.87)	-0.0062 * (-1.97)	-0.0063 * (-1.99)	-0.0058 * (-1.90)
CPRIM60	0.0134 (1.35)	0.0116 (1.16)	0.0127 (1.30)	0.0121 (1.25)	0.0175 * (1.77)
CSEC60	0.0282 * (1.91)	0.0193 (1.23)	0.0152 (0.97)	0.0122 (0.78)	0.0178 (1.27)
SGOV7088	-0.0426 (-1.23)	-0.0595 * (-1.73)	-0.0606 * (-1.78)	-0.0604 * (-1.79)	-0.0479 (-1.40)
GINI		-0.0691 ** (-3.04)			
THEIL			-0.0438 ** (-3.22)		
COEFFVAR				-0.0298 ** (-3.53)	
RTP40					-0.0022 ** (-2.40)
R-Squared	0.23	0.32	0.34	0.35	0.28

Table 8: Weighted Least Squares (with 1/GDP^2 as the weight) for Barro Type Regression with Inequality measures.

Dep. Var	(1) LGPC7088	(2) LGPC7088	(3) LGPC7088	(4) LGPC7088	(5) LGPC7088
# of Obs	81	74	74	81	81
Constant	0.0197 * (1.99)	0.0466 ** (3.84)	0.0362 ** (3.59)	0.0456 ** (4.05)	0.0343 ** (3.33)
SGDPPC70	-0.0014 ** (-2.37)	-0.0008 (-1.07)	-0.0008 (-1.16)	-0.0009 (-1.25)	-0.0002 ** (-3.52)
REVC7085	-0.0134 (-1.33)	-0.0130 (-1.45)	-0.0130 (-1.47)	-0.0118 (-1.35)	-0.0165 * (-1.74)
ASSP7085	-0.0189 (-0.86)	-0.0239 (-1.07)	-0.0255 (-1.15)	-0.0261 (-1.19)	-0.0261 (-1.27)
PPI70DVN	-0.0098 * (-1.76)	-0.0100 * (-1.98)	-0.0101 ** (-2.00)	-0.0097 * (-1.95)	-0.0087 (-1.66)
CPRIM60	0.0059 (0.65)	0.0055 (0.67)	0.0052 (0.64)	0.0053 (0.65)	0.0073 (0.85)
CSEC60	0.0019 ** (2.68)	0.0064 (0.73)	0.0046 (0.53)	0.0045 (0.52)	0.0167 ** (2.50)
SGOV7088	-0.0369 * (-1.71)	-0.0447 ** (-2.17)	-0.0455 ** (-2.24)	-0.0458 ** (-2.28)	-0.0405 ** (-2.01)
GINI		-0.0589 ** (-3.43)			
THEIL			-0.040 ** (-3.68)		
COEFFVAR				-0.0250 ** (-3.85)	
RTP40					-0.2741 ** (-3.34)
R-Squared	0.64	0.72	0.72	0.73	0.68

Even under ideal conditions inequality data is perceived as poor quality. In this case the problem is exacerbated by using income distribution data from different sources, for different income receiving unit, and for different years. Some observations are from the early seventies (and a few from the eighties for RTP40), hence endogeneity may be a concern. To correct these problems, two stage least squares is performed. In addition to the Barro regressors the following instruments are used : a dummy for socialist economies (SOC from the Barro Wolf data set), a dummy for African countries, a dummy for Latin American countries, log of initial per capita GDP and squared log of initial per capita GDP (from Summers and Heston (1991)). Using these instruments, the coefficients are slightly more negative than

Table 9: Two Stage Least Squares for Barro Type regression and Inequality variables using Barro regressors, Log of per capita GDP, Squared Log of per capita GDP, Africa dummy, Latin America dummy and Socialist Government dummy as instruments.

Dep. Var	(2) LGPC7088	(3) LGPC7088	(4) LGPC7088	(5) LGPC7088
# of Obs	72	72	72	79
Constant	0.08266 ** (2.96)	0.0526 ** (3.11)	0.0721 ** (3.23)	0.0350 ** (2.53)
SGDPPC70	-0.0032 * (-2.00)	-0.0032 ** (-2.02)	-0.0033 ** (-2.14)	-0.0030 ** (-2.20)
REVC7085	-0.0084 (-0.82)	-0.0080 (-0.81)	-0.0088 (-0.89)	-0.0047 (-0.47)
ASSP7085	-0.0542 ** (-2.31)	-0.0566 ** (-2.45)	-0.0574 ** (-2.53)	-0.0436 ** (-2.26)
PPI70DVN	-0.0060 ** (-2.23)	-0.0064 ** (2.42)	-0.0065 ** (-2.51)	-0.0061 ** (-2.20)
CPRIM60	0.0165 (1.38)	0.0172 (1.46)	0.0160 (1.40)	0.0220 * (1.87)
CSEC60	0.0113 (0.46)	0.0082 (0.33)	0.0059 (0.24)	0.0124 (0.60)
SGOV7088	-0.0725 ** (-2.27)	-0.0714 ** (-2.28)	-0.0710 ** (-2.32)	-0.0556 * (-1.90)
GINI	-0.1265 ** (-2.47)			
THEIL		-0.0707 ** (-2.59)		
COEFFVAR			-0.0454 ** (-2.70)	
RTP40				-0.0041 ** (-2.21)
R-Squared	0.32	0.34	0.35	0.28

in the OLS regressions, and all measures remain significant at the five percent level.[19]

The regression presented in table 10 adds additional variables suggested in the empirical growth literature to the base Barro regression. The variables added are: trade share of GDP averaged over 1970 to 1988, used as a measure of trade policy (STRD7088); money and quasimoney as share of GDP averaged over 1970-88 (m27088) used as a measure of size and development of the financial sector;[20] the standard deviation of inflation over the period 1970 to 1988 used as a measure of overall macroeconomic uncertainty (SDPI7088), the average of the ratio of claims on the private sector by the central bank and deposit money banks to GDP over 1970 to 1988 (DCPT7088) (Levine and King (1992)), a measure suggested as a proxy for development of financial markets, and the average number of war casualties between 1970 and 1988 (Easterly, Kremer, Pritchett and Summers(1992)). Whites' Heteroskedastic Consistent standard errors are used to correct for heteroskedasticity. As shown in table 10, adding these variables affects neither the sign nor the significance of the coefficients on the inequality measures.

The results indicate that under a broad range of assumptions, within the context of cross country growth regressions, initial inequality is negatively correlated with growth. Hence, improving equality may improve future growth prospects.

[19] These instruments are chosen, because with the exception of the socialist government dummy, they are highly significant in the first stage regression and are exogenous. The R^2 terms for the first stage regression ranges between .58 for the Theil index and .43 for the ratio measure. Excluding the socialist dummy does not change the significance of the results.

[20] Since money supply is a year end stock and GDP is a flow over the year, as suggested in p7 of Levine and King (1992) and Appendix 1 of Ghani (1992), money supply is the average of money supply at the end of the previous year and the end of that year.

Table 10 : Ordinary Least Squares with Whites' Heteroskedastic Consistent Standard Errors for Augmented Barro Type Regression.

Dep Var	LGPC7088	LGPC7088	LGPC7088	LGPC7088	LGPC7088
# OF OBS	61	56	56	56	61
Constant	0.0161 (1.40)	0.0479 ** (2.61)	0.0324 ** (2.27)	0.0482 ** (2.90)	0.0221 * (1.79)
SGDPPC70	-0.0017 (-1.38)	-0.0030 * (-1.94)	-0.0031 * (-2.00)	-0.0031 ** (-2.02)	-0.0025 ** (-2.08)
REVC7085	0.0127 (1.06)	0.0038 (0.32)	0.0031 (0.27)	0.0018 (0.15)	0.0082 (0.72)
ASSP7085	-0.0442 * (-1.71)	-0.0495 (-1.55)	-0.0511 (-1.60)	-0.0525 (-1.59)	-0.0378 (-1.51)
PPI70DVN	-0.0033 (-0.33)	-0.0009 (-0.09)	-0.0012 (-0.13)	-0.0015 (-0.16)	-0.0019 (-0.20)
CPRIM60	0.0193 ** (2.17)	0.0211 * (1.96)	0.0214 ** (2.03)	0.0210 ** (2.[illegible])	0.0207 ** (2.15)
CSEC60	0.0312 ** (2.20)	0.0263 (1.38)	0.0225 (1.20)	0.0211 (1.12)	0.0269 ** (2.12)
SGOV7088	-0.0600 * (-1.85)	-0.0668 * (-1.79)	-0.0672 * (-1.85)	-0.0672 * (-1.89)	-0.0663 ** (-2.03)
CS7088	-1.02 (-0.38)	-1.77 (-0.68)	-1.78 (-0.69)	-1.69 (-0.66)	-1.54 (-0.58)
M27088	-0.0022 * (-1.77)	-0.0025 ** (-2.55)	-0.0024 ** (-2.69)	-0.0026 ** (-2.93)	-0.0024 ** (-2.47)
SDPI7088	-0.00004 (-0.55)	0.00001 (0.24)	0.00002 (0.38)	0.00001 (0.19)	0.00002 (0.25)
STRD7088	-0.0056 (-0.75)	-0.0088 (-1.13)	-0.0084 (-1.10)	-0.0093 (-1.24)	-0.0070 (-0.98)
DCPT7088	-0.0057 (-0.43)	0.0102 (0.64)	0.0098 (0.62)	0.0081 (0.52)	0.0066 (0.43)
GINI		-0.0783 ** (-2.66)			
THEIL			-0.0459 ** (-3.06)		
COEFFVAR				-0.0328 ** (-3.07)	
RTP40					-0.0024 ** (-2.28)
R-Squared	0.37	0.45	0.47	0.47	0.42

A final topic is whether the observed relationship between growth and inequality differs for democracies and non democracies. Persson and Tabellini suggest "in a society where distributional conflict is more important, political decisions are likely to result in policies that allow less private appropriation and therefore less accumulation and growth. But the growth rate also depends on political institutions, for it is through the political process that conflicting interests ultimately are aggregated into public policy decisions."[21]

To test this hypothesis, an interaction term between regime type and inequality is added to the base regression. This interaction term is a dummy variable equal to one if the country is a democracy and zero if it is a non-democracy multiplied by the inequality variables. Hence if the t statistic on this term is significant, it indicates that inequality affects democracies and non-democracies in a different manner. Countries are classified as democracies and non-democracies using the following procedure. If a country spent more the fifty percent of the time between 1970 and 1988 as a democracy, as classified in ongoing work by Cukierman, Neyapti and Webb, than it is classified as a democracy. This list is supplemented with the classifications used in Alesina and Rodrik(1991) for countries not covered in Cukierman, Neyapti and Webb. Table 11 shows that the coefficients on the interaction terms are insignificant; the coefficients on the inequality measures remains significantly negative. Hence the null hypotheses, that democracies and non-democracies have a similar relationship between long term growth and inequality, is accepted.

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[21] Persson and Tabellini, p.1.

Table 11: Ordinary Least Squares with Whites Heteroskedastic Consistent Standard Errors for Barro type regression including inequality measures and interaction term between inequality and political system

Dep Vars	(1) LGPC7088	(2) LGPC7088	(3) LGPC7088	(4) LGPC7088
# of Obs	68	68	68	71
Constant	0.0467** (3.05)	0.0486** (3.52)	0.0330** (2.64)	0.0298** (2.45)
SGDPPC70	-0.0028** (-2.09)	-0.0029** (-2.26)	-0.0029** (-2.22)	-0.0029** (-2.85)
REVC7085	-0.0071 (-0.62)	-0.0095 (-0.84)	-0.0090 (-0.79)	-0.0093 (-0.80)
ASSP7085	-0.0555** (-2.12)	-0.0550** (-2.23)	-0.0557** (-2.24)	0.0387** (-2.85)
PPI70DVN	-0.0057* (-1.91)	-0.0061** (-2.03)	-0.0057* (-1.91)	-0.0056* (-1.82)
CPRIM60	0.0201* (1.85)	0.0207** (2.00)	0.0215** (2.05)	0.0198 (1.88)*
CSEC60	0.0175 (1.04)	0.0087 (0.53)	0.0111 (0.67)	0.0211 (1.62)
SGOV7088	-0.0226 (-0.56)	-0.0245 (-0.63)	-0.0252 (-0.64)	-0.0418 (-1.11)
GINI	-0.0785** (-3.48)			
GINIDEM	-0.0055 (-0.44)			
COEFFVAR		-0.0353** (-4.34)		
CVARDEM		-0.0025 (-0.44)		
THEIL			-0.0535** (-4.32)	
THEILDEM			-0.0061 (-0.44)	
RTP40				-0.0032** (-3.85)
RTP40DEM				-0.0012 (-0.97)
R-Squared	0.34	0.39	0.38	0.36

IV. Sensitivity Analysis

A common criticism of cross country growth regressions is that both the sign and significance of variables in cross country growth regressions are highly sensitive to the inclusion, or exclusion, of variables found to be significant in other parts of the literature. To counter concerns about the robustness of results to the inclusion of other plausible variables, Levine and Renelt (1992) propose a variant of Leamer's (1983) extreme bound analysis to test the robustness. A brief summary of the procedure Levine and Renelt (1992) propose follows[22].

(1) $Y= \beta_i I + \beta_m M + \beta_z Z + u$

The first step is to divide the independent variables into three categories; the I, or included variables, the M variable, the variable of interest; and the Z variables. The I variables are always included in the regression, as is the M variable which in this case is inequality. The M variables' coefficient, β_m, is observed to gauge its reaction to different combinations of the Z variables. The Z variables are a large pool of variables, suggested in other empirical and theoretical works as potentially important for growth, but whose importance is more controversial. The Z variables are added to the base regression, until all combinations have been tried, noting at each step β_m and its standard error.[23] The highest and lowest values of the coefficient on the variable of interest, β_m, that would be accepted at a given significance level are then computed for each combination of Z variables. After a comparison of the highest acceptable β's from all regressions, the β_m with the highest acceptable β associated to it becomes the upper extreme bound. Likewise the β_m with lowest acceptable β associated with it becomes the lower extreme bound. If the extreme bounds have the same sign, and are both significant, this

[22] For the complete description of this form of sensitivity analysis see Levine and Renelt (1992).

[23] In the first part of the analysis, following Levine and Renelt (1992), up to three variables from a pool of seven Z variables are added at any one time. This is, of course, not an exhaustive list of possible variables.

indicates that the relationship between the M variable and growth is not highly sensitive to the inclusion of other variables, providing strong evidence as to the robustness of the results.

At this point, it should be noted that all that is really needed to show a relationship between the variable of interest and growth is the sign (and significance) of the variable of interests' coefficient in the "true" growth regression.[24] A variable which is related to growth can become insignificant, or switch signs, due to the inclusion of irrelevant Z variables, or the exclusion of relevant Z variables. On the other hand, in an area such as cross country growth regressions, where there is little agreement on the precise form of the growth regressions and where theory indicates a large number of possibly relevant variables, such a procedure may increase the readers' confidence in the results presented.

Another concern is the division of plausible variables into the I and Z variables. The I variables used in the first section are the Barro regressors from the previous section. This base regression is preferred to the base regression used in Levine and Renelt (1992), due to doubts about the exogeniety of investment (one of the I variables in Levine and Renelt (1992)), and because many regressors in the Barro regression are significant at the five and ten percent levels. Results are also presented using the Levine and Renelt (1992) base regression. In a later section the Barro regressors that are insignificant in the base regression, when inequality variables are included, are dropped one at a time until all regressors are significant at the ten percent level in at least one of the regressions. This further excludes CSEC60, secondary enrollment rates, and REVC7085, the average number of revolutions and coups.

The seven Z variables are money and quasimoney as percent of GDP averaged between 1970 and 1988 (M27088), war casualties per capita averaged between 1970 and 1988 (CS7088), ratio of claims on the private sector by the central bank to GDP averaged between 19708 and 1988 (DCPT7088), the average inflation rate between 1970 and 1988 (PI7088), Standard Deviation of the Inflation between 1970 and 1988 (SDPI7088), trade share of GDP averaged between 1970 and 1988 (STRD7088), and the ratio

[24] For a discussion of these and other problems in sensitivity analysis see McAleer, Pagan and Volcker (1985).

of the assets of deposit money banks to the combined assets of deposit money banks and the central bank (BTOT7088). These variables are chosen to proxy for aspects of monetary and trade policy, as well as macroeconomic and social stability. The base regression includes a proxy for fiscal policy (SGOV7088). Throughout the sensitivity analysis Whites' Heteroskedastic Consistent Variances are used.

Results are presented below in table 12. The Gini Coefficient, coefficient of variation and Theils' index remain significantly negative at the five percent level in all regressions. The final measure, RTP40 , is significantly negatively correlated with growth at the ten percent level. These results confirm that in a wide variety of specifications, inequality measures are significantly and negatively correlated with growth.[25]

The sensitivity analysis is next expanded to include more than three additional regressors at one time. In addition, two regressors from the base Barro regression that are insignificant once inequality measures are included, secondary enrollment rate in 1960, and average number of revolutions and coups are dropped from the base regression (I variables) and added to the pool of Z variables.[26] Growth of population, used in the base regression in Levine and Renelt (1992) is also added to the pool of Z variables. All possible combinations of these ten variables (with up to all ten variables added at the same

[25] Sensitivity Analysis is also conducted using the base regression from Levine and Renelt (1992), which contains the following variables: initial GDP per Capita (SGDPPC70), investment share of GDP averaged over 1970 to 1988 (SINV7088), growth rate of population (LGPP7088) and secondary enrollment rates (CSEC60). The seven Z-variables used are also similar to those used in the paper by Levine and Renelt; government share of GDP (SGOV7088), trade share of GDP (STRD7088), average inflation rate (PI7088), standard deviation of inflation (SDPI7088), and number of revolutions and coups (REVC7085). To proxy for monetary phenomenon slightly different measures from those used in the Levine and Renelt paper were used. The measures used were ratio of claims on private sector by the central bank and deposit money banks (DCPT7088) and ratio of money and quasi money to GDP (M27088). Once again, following Levine and Renelt, a maximum of three variables were added at the same time. Using this specification the Gini coefficient, Theils' index and coefficient of variation remain significantly negatively correlated with growth at the ten percent level. RTP40 remains negatively correlated with growth, but becomes insignificant at the conventional significance levels of five and ten percent.

[26] Primary enrollment rate in 1960, although also insignificant in the base regression, is not dropped. Dropping CSEC60 and REVC7085 from the base regression makes CPRIM60 significant when RTP40 is the measure of inequality . In addition human capital variables have been stressed throughout the literature as especially important for growth. If CPRIM60 is dropped, then in the RTP40 regression CSEC60 becomes significant also. However,CPRIM60 is preferred since in the extended regression as shown in table 10, it is significant at least the ten percent level with all inequality measures. Using CSEC60 instead of CPRIM60, the coefficient of variation remains significant at the five percent level; Gini and Theil are significant at the ten percent level, and RTP40 remains negative, but is insignificant at conventional significance levels.

Table 12: Results from Sensitivity Analysis for Inequality Variables, using Barro type regression as Base Regression

	#obs	Coeff	S.E	T-stat	Included Variables
COEFFVAR					
High	67	-0.0243	0.0087	-2.81	CS7088, M27088, SDPI7088
Low	61	-0.0376	0.0095	-3.95	BTOT7088, PI7088, SDPI7088.
THEIL					
High	70	-0.0337	0.0128	-2.63	CS7088, SDPI7088, STRD7088
Low	61	-0.0563	0.0147	-3.82	BTOT7088, PI7088, SDPI7088
GINI					
High	67	-0.0527	0.0237	-2.22	CS7088, M27088, SDPI7088
Low	61	-0.0868	0.0258	-3.37	BTOT7088, SDPI7088, PI7088
RTP40					
High	64	-0.0020	0.0010	-1.94	CS7088, SDPI7088, DCPT7088
Low	64	-0.0027	0.0009	-2.92	M27088, BTOT7088, STRD7088

Table 13: Extended Sensitivity Analysis

	#obs	Coeff	S.E	T-stat	Included Variables
COEFFVAR					
High	70	-0.0237	0.0095	-2.51	STRD7088, SDPI7088, CS7088, LGPP7088, CSEC60
Low	57	-0.0403	0.0118	-3.41	REVC7085, PI7088, BTOT7088, LGPP7088, DCPT7088
THEIL					
High	70	-0.0341	0.1532	-2.23	STRD7088, SDPI7088, CS7088, LGPP7088
Low	57	-0.0591	0.0179	-3.29	REVC7085, PI7088, SDPI7088, M27088, BTOT7088, LGPP7088, DCPT7088
GINI					
High	70	-0.0462	0.0240	-1.93	STRD7088, SDPI7088, CS7088, CSEC60, LGPP7088
Low	58	-0.1010	0.0280	-3.61	REVC7085, STRD7088, PI7088, SDPI7088, M27088, BTOT7088
RTP40					
High	64	-0.0018	0.0011	-1.64	STRD7088, SDPI7088, CS7088, DCPT7088,BTOT7088, LGPP7088 CSEC60
Low	63	-0.0032	0.0010	-3.26	STRD7088, REVC7085, PI7088, SDPI7088, M27088, BTOT7088

time) are added to the base regression (now excluding REVC7085 and CSEC60 since they are included in the pool of doubtful variables).

The results are presented above in table 13. Two of inequality measures, the coefficient of variation and Theils' index, remain significant at the five percent level, and the Gini coefficient is still significant at the ten percent level. All measures of inequality remain negatively correlated with growth in all regressions, although the ratio measure becomes insignificant at conventional significance levels. These results confirm a robust and negative relationship between inequality and growth.

V. Conclusions

In summary, the empirical results are as follows:

1) Inequality is negatively, and robustly, correlated with growth. This result is not highly dependent upon assumptions about either the form of the growth regression or the measure of inequality. The analysis includes a variation of Leamer's extreme bounds analysis proposed by Levine and Renelt (1992).

2) Although statistically significant the magnitude of the relationship between inequality and growth is relatively small. Decreasing inequality from one standard deviation above to one standard deviation below the mean increases the long term growth rate by approximately 1.3% per annum.[27]

3) The correlation between inequality and growth is not dependent upon whether the government is a democracy or a non-democracy. When an interaction term between the type of regime and inequality is included in the base regression it is insignificant at conventional significance levels.

4) The cross country data on inequality follows Kuznets' inverted U shape.

Some care should be taken when interpreting these results. Although inequality is negatively

[27] Using Gini coefficients and coefficient from the base Barro regression, going from one standard deviation above the mean value to one standard deviation below the mean value

correlated with growth, this does not necessarily imply that "soak the rich" policies will improve long term growth. First, theoretical work on inequality and growth has stressed that this negative correlation is caused by high levels of inequality provoking high levels of governmental economic intervention. Hence, the reason for this correlation may be that "soak the rich" policies are less necessary where there is less inequality. Second, although the partial correlation is robust, the direction of causality has not been determined and the effects of specific income distribution policies have not been tested. Finally, looking at the empirical results, once inequality variables are included in the base regression size of government consumption is negatively, although not robustly, correlated with growth in many specifications. Hence if policies designed to decrease inequality result in larger government consumption and the cost of increased government consumption outweighs the benefits of greater equality, long term growth may be harmed. These results, however, do indicate quite conclusively that inequity is not a necessary precondition for growth.

Appendix I : Data

The data used in the analysis is from BESD, the World Bank database with the following exceptions[28]. Per capita gross domestic product, government share of GDP, trade share of GDP, and investment share of GDP are from Summers and Heston (1991). Assassinations per million population, and revolutions and coups, are constructed from the raw data used in the Barro-Wolf data set. Primary and secondary enrollment rates in 1960 are obtained from the Barro-Wolf data set, but are supplemented with data from SOCIND, United Nations Social Indicators, which is part of the World Bank data base. The War Casualties data is from Easterly, Kremer, Pritchett, and Summers (1992) and the two financial variables, DCPT7088, the ratio of claims on the private sector by the central bank and deposit money banks to GDP, and BTOT7088, the ratio of the assets of deposit money banks to the combined assets of deposit money banks and the central bank are from raw data from King and Levine (1992). The raw income distribution data used to construct the inequality variables comes from four basic sources. The primary source is SOCIND. This is supplemented by Jain (1975), and "A Survey of National Sources of Income Distribution Statistics" published by the United Nations(1981). The quintile income distribution data, used for some points in RTP40, is from Lecallion et al (1984) and United Nations (1985).

In addition to the general problems encountered in cross country growth regressions there are additional problems specific to inequality measures.[29] A problem in cross country studies concerning inequality is that data on inequality tends to be very sparse. To deal with this concern, as in Alesina and Rodrik (1991) and Persson and Tabellini (1990), income distribution is measured in different years for

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[28] With the exception of the inequality data, the data used in the following analysis is from William Easterly and Sergio Rebelo, "Fiscal Policies and Economic Growth: An Empirical Investigation", part of an ongoing World Bank research project "How Do National Policies affect Long Term Growth?"

[29] See Easterly, King, Levine and Rebelo (1991) or Levine and Renelt (1992) for a discussion of common problems in growth regressions.

different countries. It would seem plausible that income distribution changes slowly over time, which may indicate that this is the most appropriate way to deal with the sparseness of data. The income distribution data used to construct COEFFVAR, GINI and THEIL are from the eighteen year period between 1958 (Jamaica) and 1976 (Botswana, Dominican republic, Italy, Nepal and El Salvador) with the majority of these observations coming from between 1960 and 1970. Since endogeneity is a potential concern, data before 1970 is preferred to data from between 1970 and 1976. The final measure RTP40 includes additional observations from the early eighties for a few countries. Since these data are in quintiles, and not deciles as used to construct the other measures, COEFFVAR, GINI and THEIL do not include these points.

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